CHAPTER V

SUMMARY AND CONCLUSION

Introduction

The United Nations Framework Convention on Climate Change (UNFCCC, 2016) defined "Climate Change" as a variation in the composition of the entire atmosphere that is related directly or indirectly to human activity. El Nino is related with the Pacific Ocean, which inhabits nearby one-third of the Earth's surface. El Nino is a climate occurrence in the equatorial Pacific when sea surface temperatures exceed a threshold of +0.5 degrees Celsius (and cools by the same margin during alter La Nina). Agriculture is one of the maximum exposed sectors to climate change because to its inherent sensitivity, (Rupan Raghuvanshi et.al., 2017). Climate change has a direct impact on agricultural output and efficiency. In terms of production, agricultural practices, environmental effects, rural space, and variation, it has an influence on agriculture. In India, climate change would result in further numerous floods, inferior crops, and an upturn in the occurrence of risky climate actions such as cloud bursts and flash floods.

India was not a water wealthy country and promote challenged due to negative impact of climate change, huge wastage owing partly to poor supervision and unclear water pricing policies. India received an average of 4,000 billion cubic meters of precipitation every year. However, only 48 per cent of it was used in India’s surface and groundwater bodies (Vibha Dhawan, 2017). A dearth of storage procedure, lack of adequate infrastructure, inappropriate water management has created a situation where only 18 to 20 per cent of the water was actually used. India’s annual rainfall was around 1183 mm, out of which 75 per cent was received in a short span of four months during monsoon.

Agriculture is the origin of Indian economy and provides food and livelihood security to a substantial section of the Indian population. The impact of climate change as witnessed in recent times has immense potential to adversely affect agriculture in this country in a variety of ways. As a large part of the arable land in India is rain-fed, the productivity of agriculture depends on the rainfall and its pattern. Agriculture will be adversely affected not only by an increase or decrease in the overall amounts of rainfall but also by shifts in the timing of the rainfall.

Earlier Studies

Stein and Burton,(1998) (Zaheer Baber,1996) (Gupta, 2004). (Roy, 2006) (Dev, 2006) (Denis J. Murphy, 2007) is focused on the Historical Background of Agriculture**.** Deressa

et.al., (2005) Mall, R.K., (2006) Raymond Guiteras (2007) Yinhong Kang (2009) Stephanie Jamet and Jan Corfee-Morlot (2009) Angles et.al., (2011), Carlos E. Ludena and Carla Mejia (2012) Shreekant Gupta (2012), Valizadeh et.al., (2013), Birthal, B.S (2014), Harpreet Kaur and Simrit Kaur (2016), Subodh Dhakal (2016) Subodh Dhakal et.al., (2016) Subodh Dhakal et.al., (2016) Harpreet Kaur and Simrit Kaur (2016) Tripathi and Misra (2017) Shalini Chandra and Yogita Kalra (2017) Rupan Raghuvanshi (2017) studied on Significance of Agriculture, Baljinder Kaur (2011), Brajesh Jha and Amarnath Tripathi (2011), Aravind Moorthy et.al., (2012), Asha Latha et.al.,(2012), Syed Ali Fazal (2013) G. Sridevi et.al., (2014) ToshichikaIizumi and Navin Ramankutty (2015) Yohannes H (2016) Shalini Chandra and Yogita Kalra (2017) Surender Kumar and Priyanka (2017) estimated the Impact of Climate Change and Agriculture. Birthal et.al.,(2006) Meena et.al.,(2010) Madhur Gautam et.al., (2012) Olalekan Paul Akande (2012) Shumet Asefa (2012) Singh,O.P.,(2014) Suranjana Dasgupta and Sankar Kumar Bhaumik (2014) Andreas Exenberger et.al., (2014) Baljinder Kaur et.al., (2015) Amarender Reddy. A (2015) Srivastava, et.al., (2015) Thakur Prasad Sharma Wagle (2016) Pia Ghoshal and Bhaskar Goswami (2017) Hui Li et.al., (2017) Janet Horsager Malacarne (2017) Xi Ai et.al., (2018) examined the Problems of Climate Change and Agriculture.

Research Gap

There have been many studies working on climate change adoption in Agriculture'' in different parts of India. Stein, Burton,(1998) (Zaheer Baber,1996) (Gupta, 2004). (Roy, 2006) (Dev, 2006) (Denis J. Murphy, 2007) Deressa et.al., (2005) Mall, R.K., (2006) Raymond Guiteras (2007) Yinhong Kang (2009) Stephanie Jamet and Jan Corfee-Morlot (2009) Angles et.al., (2011), Carlos E. Ludena and Carla Mejia (2012) Shreekant Gupta (2012), Valizadeh et.al., (2013), Birthal, B.S (2014), Harpreet Kaur and Simrit Kaur (2016), Subodh Dhakal (2016) Subodh Dhakal et.al., (2016) Subodh Dhakal et.al., (2016) Harpreet Kaur and Simrit Kaur (2016) Tripathi and Misra (2017)Shalini Chandra and Yogita Kalra (2017) Rupan Raghuvanshi (2017). Not many studies have done climate change and its impact on Agriculture in the Coimbatore district. The present study differs from earlier studies. It is based on large sample size and also attempts to assess the Impact of Climate Change on Agriculture in Selected Farm Households in enhancing issues, challenges and improving agriculture production.

Objectives

1. To study the general profile of the selected farm households
2. To identify the important climatic problems faced by the farm households

3. To analyze the crop diversification in the selected study blocks
4. To estimate the technical efficiency of crops diversified in the selected study blocks
5. To study the soil and water conservation measures and ICTs usage in the selected study blocks

Hypothesis

1. There is a shift from cereals to pulses and spices
2. There are no important climatic problems faced by the selected farm households
3. There is no significant relationship between climatic and farm input factors on technical efficiency
4. There is no relationship between ICTs tools usage and socio-economic problems.

Methodology

As the study was mainly based on primary data, the sampling respondents of the study were selected through multistage systematic stratified sampling techniques. In the first stage the 12 blocks in Coimbatore district viz, Anamalai, Annur (33.5), Karamadai, Kinathukadavu, Madukkarai, Periyanaickenpalayam, Pollachi North, Pollachi South, Sarkarasamakulam, Sulthanpet, Sulur, and Thondamuthur (80.59). Among the 12 blocks, the researcher has chosen among the percent of the irrigated area to the total cultivable area. In the selection of the sample households, the researcher first identified the higher and lower percent of the irrigated area to the total cultivable area. It was found that Thondamuthur block was a higher percent of the irrigated area to total cultivable area with 10 villages and Annur block was found as a lower percentage of the irrigated area to total cultivable area with 22 villages. There were 330 farm households in the Thondamuthur block and 330 farm households in the Annur block were selected by using the Rao Sample size calculator the study employs 660 sample respondents. The period of the study was from the year 2018-2020. The data for the study were collected from both primary and secondary sources. The information on the nation, state, district profile, block profile, farmer's details, crop details, and other information was collected from the various reports from government organizations. Primary was collected through the personal interview method from the sample farm household respondents. Interview schedules were used to collect details related to the study from the sample farm household respondents. A pilot study was conducted to identify the gaps in the interview schedule. Based on the observation, during the pilot study, the schedule was modified (Annexure-1) and the survey was conducted between May 2018 and June 2019. The data were collected from 660 sample holdings representing marginal farmers (less than 1 ha), small farmers (1.01 to 2.0 ha), semi-medium farmers (2.01 to 4.0 ha), medium farmers

(4.01 to 10.0 ha), and large farmers (greater than 10 ha) Ministry of Agriculture (2019). The study was undertaken that marginal and small farmers were pooled and named small farm category (1 to 2 ha), and semi medium and medium farmers were pooled and named medium farm size category (2 to 10 ha), while more than 10.0 ha farmers represent large size farmers. Distribution of the sample farmers based on land operational holdings in the Thondamuthur block showed that out of 330 total sample farmers, the small farmers accounted for 72 percent, medium farmers constitute 26 percent, and large farmers 2 percent. In the Annur block, out of the 330 total sample farmers, the small farmers accounted for 73 percent, medium farmers 25.02 percent, and large farmers constitute 1.08 percent. The statistical tools employed are descriptive statistical, correlation of co-efficient, Factor analysis, crop diversification Index and Cobb Douglas Production Function Theory.

Findings of the Study

Community wise analysis reveals that both in the Thondamuthur and in the Annur blocks, OBCs constitute a major proportion with 54.24 and 60.61 per cent respectively. The farm households are mostly headed by males, the percentages being 76.67 in the Thondamuthur block and 69.39 in the Annur block. The average size of a family in the Thondamuthur block and in the Annur block is three in each. But the large farmers in both the blocks have their average family size exceeding three. The breakdown of joint family system in India is revealed in the current study also. Nuclear family system is practiced among 83.03 per cent of the farm households in the Thondamuthur and 82.73 per cent of the farm households in the Annur blocks. Most of the small farmers follow nuclear family system both in the Thondamuthur (85.71 per cent) and Annur blocks (84.87 per cent). The per centages are 76.19 and 75.64 among the medium farmers in the Thondamuthur and Annur blocks respectively. The data on the age of the head of the farm households in both the blocks reveals that about 30 to 40 per cent of the families of the small and medium farmers are in the age group of 40 to 50 years. But, 60 to 70 per cent of the families of the large farmers in both the blocks are in the age group of 50 plus.

The land was characterized as ‘wet land’, ‘orchards’ and ‘dry land’. In the Thondamuthur block, on an average small farmers own 1.991 hectares of land, medium farmers 5.9604 hectares of land and large farmers 10.881 hectares of land. On an average, the farmers in the Thondamuthur block own 18.8324 hectares of land. Among the land owned and used, orchards constitutes the major proportion across all the types of farmers (55.45 per cent) followed by wet land by 41.81 per cent of the farmers. Dry land constitutes a lesser per centage. On an average, a farmer in Thondamuthur block owns 2.73 per cent of dry land. In

Annur block also, orchards constitutes a major proportion (50.30 per cent) followed by wet (15.45 per cent) and dry land (34.25 per cent).percentage of farmers has their own farm land are 65.76 and 60.61 in Thondamuthur and Annur block The most of the farmers involved in faming activities of more than ten years with the percentages of 65.15 and 66.36 while proportion of small, medium and large farmers as 61.90 per cent, 73.81 per cent and 66.67 per cent in Thondamuthur while in Annur block 68.07 per cent of small farmers, 62.82 per cent of medium farmers and 57.14 per cent of large farmers respectively.

Thondamuthur block is covered with red soil (33.64 per cent), black soil (39.39 per cent), red sandy (17.58 per cent) and sandy coastal alluvium (9.39 per cent). Annur block is covered with black soil (48.48) red soil (29.70) red sandy (11.82 per cent) and calcareous (10 per cent).Majority of farmers under the usage of fertilizers where 49.39 per cent and 52.12 per cent of N next to P accounts for 20.91 per cent and 24.24 per cent where usage of K is 12.42 per cent both the blocks, while the usage of organic manure is 17.27 per cent and 11.21 per cent in both the blocks respectively. Thus the fertility of land reveals that less fertile accounts for 34.54 per cent, fertile land is 36.06 per cent, high fertile land is 25.15 per cent where infertile land is 4.24 per cent in Thondamuthur block and 36.36 per cent of less fertile land followed by fertile land is 35.76 per cent, high fertile land is 23.93 per cent and infertile land is 3.93 per cent in Annur block respectively.

Water resources of selected farm households where the type of wells contribution of canal is 28.79 per cent and 71.21per cent of wells and there is no lake and other water sources in Thondamuthur block. In Annur block there is absence of canals while wells accounts for 81.21 per cent, lakes of 18.48 per cent and other water sources of 0.61 per cent respectively. the type of wells contribution of open well is 39.39 per cent while bore well is 43.93 per cent under by both open with bore well is 16.67 per cent in Thondamuthur block and in Annur block reveals that open well is 40.00 per cent while bore well is 45.45 per cent under by both open with bore well is16.36 per cent respectively. Usage of drip irrigation is higher in the per cent of 36.67 per cent and 41.82 per cent when compared to other form irrigation activities in both Thondamuthur and Annur blocks.

The cropping pattern in Thondamuthur block reveals that vegetables (20.30 per cent), Pulses (12.42 per cent), Coconut (11.51 per cent), Cereals (10.61per cent), Fruits (10.30 per cent), Spices and condiments (9.09 per cent), Flowers (7.27 per cent), Medicinal plants (5.15 per cent), Sugarcane (4.24 per cent) Curry leaves (3.03 per cent) Groundnut (3.94) and Cotton (2.12 per cent) and in Annur the cropping pattern as Curry leaves (14.85 per cent),

Cereals (11.51 per cent), Flowers (10.90 per cent) Fruits and Spices and condiments (10.60 per cent), Pulses (9.09 per cent), vegetables (8.18 per cent), Coconut and Groundnut (7.58 per cent), Cotton (5.45 per cent), and Medicinal plants (5.15 per cent). There is proportionate change in cropping pattern by farmers due to climate factors.

Majority of the farmers affected by lack of mechanization as 18.48 per cent next to inadequate storage facilities as 17.58 per cent, scarcity of capital as 11.82 per cent inadequate transport as 11.21 per cent, agriculture marketing as 10.30 per cent and other factors were affected by less than 10 per cent in Thondamuthur while in Annur block most of the farmers affected by soil erosion of 18.79 per cent, irrigation of 17.58 per cent next to lack of mechanization as 11.82 per cent and fertilizers as 11.21 per cent where the other per cent affects less than 10 per cent respectively. Most of the farmers affected by the soil erosion in Annur block and Lack of mechanization in Thondamuthur block. In Thondamuthur block 53 per cent and in Annur 64.85 per cent under water conservation measure and the soil conservation measure is practiced more than two times in a year in both the blocks.

Crop Diversification

Crop diversification during the past and present crop production due to climate change was measured using the Hirschman-Herfindhal diversification index.

In Thondamuthur block the diversification index calculation clearly explains that present have more diversification comparatively to past have 0.986 diversification index for vegetables wherein present have 0.999. In cereals present had 0.999 of diversification and past attained only 0.991. In the selected block, among the farm households small farmers had maximum crop diversification mainly in cereals (0.999), flowers (0.992), coconut (0.996) and spices and condiments (0.993) respectively. In Annur block the diversification index calculation clearly explains that present have more diversification comparatively to past have 0.921 diversification index for curry leaves wherein present have 0.998. In cereals present had 0.992 of diversification and past attained only 0.953. In the selected block, among the farm households small farmers had maximum crop diversification mainly in cereals (0.992), flowers (0.991), coconut (0.995) and spices and condiments (0.997). Through this analysis we clearly demonstrate that crop diversification favour to selected small farm households.

The Modified Entropy Index calculation clearly ranked that present adopters have more diversification comparatively to past. In Thondamuthur block the Present have 0.001 diversification index for vegetables ranking 1st wherein past have 0.008. The cereals and condiments present had 0.002 and 0.00 diversification ranking 2nd and past attained 0.024 and

0.014 per cent. In the Thondamuthur block, among the farm households small farmers had maximum crop diversification mainly vegetables (0.004), cereals (0.007), pulses (0.005), and fruits (0.006).The fruits had 0.006 diversification index ranking 3rd wherein past had 0.008. In Annur block the Present have 0.001 diversification index for curry leaves ranking 1st wherein past have 0.020. The pulses and flowers present had 0.004 diversification ranking 2nd and past attained 0.023 and 0.010 per cent. In the Annur block, among the farm households small farmers had maximum crop diversification mainly curry leaves (0.005), cereals (0.008), pulses (0.010), and fruits (0.017). The fruits and spices and condiments had 0.003 diversification index ranking 3rd wherein past had 0.024 and 0.013. Through Modified Entropy Index among the selected farm households the study found that crop diversification favors more to present adopters with special reference to small farmers. The study indicated that present play vital role in improving farming practices.

The results of Cobb-Douglas function for the Thondamuthur and Annur block. In Thondamuthur block the cropped area and the reference crops were positively associated with the size of land holding. Human labour use per hectare for vegetables and pulses was higher on small and medium farmers then compared large farmer's counterparts. In Annur block the cropped area and the reference crops were also positively associated with the size of land holding. Human labour use per hectare for spices and condiments and cereals was higher on small and medium farmers then compared large farmer's counterparts.

In Thondamuthur block the area under the concerned crop as well as quantity of fertilizers used to tend to be significant determinant of output. Human labour contributed significantly to vegetables and pulses output but not so much to cereals and spices and condiments. The elasticity coefficient of bullock labour is not statistically significant for the selected crops. In the Annur bock the area under the concerned crop as well as quantity of fertilizers used to tend to be significant determinant of output. Human labour contributed significantly to cereals and spices and condiments output but not so much to vegetables and pulses. The elasticity coefficient of bullock labour is also not statistically significant for the selected crops.

Estimated technical efficiency for the selected block farm households. The average level of Technical efficiency is estimated at 83 per cent indicating that the output can be raised by following efficient crop management practices without having to increase the level of application of inputs. It was observed that about 15 per cent of the farmers have harvesting lesser than 50 per cent of the Frontier output where little more than one third was 40 per cent where realising more than 90 per cent of the frontier output. It was also observed that most of

the farmers (26 per cent) operated at the efficiency level between 70 and 90 per cent. Mean technical efficiency range from 0.72 on small farmers to 0.84 medium farmers and 0.86 on large farmers in Thondamuthur block. In Annur block average level of Technical efficiency is estimated at 84 per cent indicating that the output can be raised by following efficient crop management practices without having to increase the level of application of inputs. It was observed that about 16 per cent of the farmers have harvesting lesser than 50 per cent of the Frontier output where little more than one third was 39 per cent where realising more than 90 per cent of the frontier output. It was also observed that most of the farmers (24 per cent) operated at the efficiency level between 70 and 90 per cent. Mean technical efficiency range from 0.76 on small farmers to 0.80 medium farmers and 0.85 on large farmers respectively.

The estimated elasticity coefficients for area under the pulses and fertilizer are statistically significant at 1 per cent level. The elasticity coefficient for human labour use was statistically significant at 5 per cent level. The estimated value of $\sigma u^2$and σv^2 were 0.086 and 0.001 respectively. A high value of λ (0.959), the ratio of the variance of the farm specific Technical efficiency to the total variance of output shows that about 95 per cent of the difference between the observed and the frontier output was mainly due to inefficient use of resources which are under the control of the selected farm households in Annur block.

The Technical efficiency of the pulses growers across the farm households. The estimated technical efficiency ranged from 79 per cent of the potential yield on medium farmers to 80 per cent on small farmers, 75 per cent of large farmers with the average of 81 per cent for all the farm households. It is observed that about a 24 per cent of the farms realized less than 50 per cent of the potential production whereas 22 per cent of the farm households harvested more than per cent of the potential pulses. The frequency distributions in Annur block of estimated technical efficiency for the groundnut growers across the farm households. The estimated technical efficiency ranged from 82 per cent of the potential yield on medium farmers to 81per cent on small farmers, 86 per cent of large farmers with the average of 80 per cent for all the farm households. It is observed that about a 23 per cent of the farms realized less than 50 per cent of the potential production whereas 24 per cent of the farm households harvested more than per cent of the potential pulses.

The technical efficiency for growing vegetables varied from 80 per cent on small farmers to 76 per cent on medium farmers. On an average pulses, growers are operating at 80 per cent level of efficiency and it ranged from 76 per cent on the medium formers to 83 per cent of the potential output for small farmers. Wide variations are observed in the level of efficiency in the case of spices and condiments and are very from 79 per cent on medium

farmer 21 per cent on small farmers. A sizable proportion of farmers are found to operate at an efficiency level of less than 70 per cent of the potential.

Usage of ICTs in selected farm households where the majority of the farmers benefited by getting the information of market as 20 per cent in Thondamuthur and 23.03 per cent in Annur block next to easy access as 20.61 per cent and 21.52 per cent in both the blocks. The farmers are mostly benefited while using e-agriculture method in cultivation. The e-agriculture farmers are highly benefited in up to date information in weather forecasting and timely advice and market information has increase in agriculture production has resulted in increasing the standard of living of farmers. Table explains the benefits of ICTs by selected farmers, majority of the farmers are benefited by Weather forecasting and regional language is being 22 per cent and 20 per cent respectively, per centage of the farmers in ICTs benefits in timely advice by 18 per cent.

Conclusion

Global climate change, its causes and impacts are one of the most emerging issues in science and technology domain. India, a tropical country, is facing its impacts through droughts, floods, cyclones, heat waves, hailstorms, and coastal salinity which have become threats to sustainable development. About 70 per cent of the Indian population is directly or indirectly associated with agriculture and sub-sectors, and major Sustainability Development Goals (SDGs) are expected to be met from this sector. Increasing global temperature due to the emission of enormous amount of green-house gases from various sources is the cause of climate change and impacts. Extreme temperature and its erratic events disrupt the activities of all the existing lives on the planet by means of severe damage or loss. Assessment of the impacts and a comprehensive understanding of the benefits of adaptation options over combating the uncommon incidents of climate change is pivotal in the current scenario to sustain life. The impact of climate change on Indian agriculture has created serious things of concerns for India, which are urgently needed to deal with in absence of which it can very badly and severely affect India and its billion populations. The severe concerns of climate change on Indian agriculture are; in the situation of enhancing production, the productivity of agriculture climate change will adversely affect and its contribution to the development of the economy will be further marginalized. The uncertainty and variations in rainfall will hamper production especially of food grains and intensify the want for food and food security of the majority of Indians especially from the socially and economically deprived sections of the society. Climate change will adversely affect the water supply through rivers and further intensify drinking water availability and irrigation facilities for the development of the

agriculture of India. Such climatic fluctuations could adversely affect agricultural sustainability resulting in unforeseen situational shortages which could also impact other economic sectors. The hampered growth of agriculture by climate change will also affect unemployment, poverty, and inequality in the Indian economy.

Recommendations of Future Research

Diversification of rural income through livelihood and crop diversification and managing the village resources judiciously by the community participation programme for stability and sustainability.

Managing climate risks efficiency through weather based agro advisories with a higher resolution and developing weather insurance products encouraging weather-crop research program at different agro climatic regions.

Evaluation of proven technologies on farm management practices for addressing climate variability in the farm fields.

Development and adaption of location specific techniques for water efficient agriculture.

Integration of climate change initiatives with the national agriculture policies

Suggestions

Maintaining crop health across the planet, in turn, is a key requirement for climate change mitigation, as well as the conservation of biodiversity and the provision of ecosystem services under global change.

Information gathered so far has been fragmented and a comprehensive analysis of climate change impacts on agriculture is required. Experimental research on a diverse range of crop and biotic and abiotic systems is necessary to improve comprehension of climate change impacts on agriculture.

To maintain ecosystem health and services under variable, unpredictable or unknown conditions, we need more resilient systems, decentralization, participatory research and breeding networks. At the same time, increased involvement of the many stakeholders and scientistsfrom outside plant pathology shows the importance of considering trade-offs.

Increasing diversity would be in favour of a land-sharing approach, but may be relevant also to land-sparing scenarios (e.g. at the margin of fields), depending on the spatial and temporal scale and the type of diversity (genetic, species, species turnover, ecosystem) considered.